

**WHAT IS CLAIMED IS:**

- 1                   1.     An apparatus for treating a patient comprising:  
2                    an expandable body having a proximal end, a distal end, a longitudinal axis  
3                   therebetween, and at least one microstructure having an attached end attached to the body and  
4                   a free end in an undeployed position along the expandable body,  
5                   expansion of the body creating forces which deploy the at least one  
6                   microstructure from the undeployed position to a deployed position wherein the free end  
7                   projects radially outwardly from the expandable body.
- 1                   2.     An apparatus as in claim 1, wherein the at least one microstructure has  
2                   a directional axis between the free end and the attached end, and wherein the directional axis  
3                   extends along the longitudinal axis while the at least one microstructure is in the undeployed  
4                   position.
- 1                   3.     An apparatus as in claim 1, wherein the at least one microstructure has  
2                   a directional axis between the free end and the attached end, and wherein the directional axis  
3                   extends across the longitudinal axis while the at least one microstructure is in the undeployed  
4                   position.
- 1                   4.     An apparatus as in claim 1, wherein the free end has a pointed shape.
- 1                   5.     An apparatus as in claim 4, wherein the pointed shape includes a single  
2                   point, a multiple point, an arrow shaped point including a pointed tip and at least one  
3                   undercut, or a combination of these.
- 1                   6.     An apparatus as in claim 1, wherein the free end has a flat-edged  
2                   shape.
- 1                   7.     An apparatus as in claim 1, further comprising a material carried by the  
2                   at least one microstructure, wherein the material is delivered to the patient by the at least one  
3                   microstructure.
- 1                   8.     An apparatus as in claim 7, wherein the material comprises at least a  
2                   gene, at least a drug or a combination of these.

- 1                   9.     An apparatus as in claim 7, wherein the material is coated on a surface  
2 of the at least one microstructure.
- 1                   10.    An apparatus as in claim 7, wherein the material is held in a lumen  
2 within the at least one microstructure.
- 1                   11.    An apparatus as in claim 1, wherein the expandable body comprises an  
2 endoluminal stent.
- 1                   12.    An apparatus as in claim 11, wherein the stent is sized for positioning  
2 within a vascular lumen.
- 1                   13.    An apparatus as in claim 11, wherein the stent is configured to  
2 maintain the deployed position and remain in the lumen.
- 1                   14.    An apparatus as in claim 1, wherein the expandable body is retractable  
2 to the undeployed position.
- 1                   15.    An apparatus as in claim 1, wherein the expandable body is comprised  
2 of shape-memory alloy, stainless steel, titanium, tantalum, vanadium, cobalt chromium alloy,  
3 polymer, or a combination of these.
- 1                   16.    An apparatus for treating a patient comprising:  
2                   a radially expandable body having a proximal end, a distal end, a longitudinal  
3 axis therebetween, and a plurality of microstructures, each microstructure having first and  
4 second supports and a free end, the supports affixed to associate first and second adjacent  
5 portions of the radially expandable body,  
6                   expansion of the expandable body within the patient effecting relative  
7 movement between the associated first and second portions of the expandable body,  
8                   the relative movement deploying the microstructures from an undeployed  
9 position along the expandable body to a deployed position with the free end projecting  
10 radially outwardly from the expandable body.
- 1                   17.    An apparatus as in claim 16, wherein the at least one microstructure  
2 has a directional axis between the free end and the associate first and second adjacent

3 portions, and wherein the directional axis extends along the longitudinal axis while the at  
4 least one microstructure is in the undeployed position.

1 18. An apparatus as in claim 16, wherein the at least one microstructure  
2 has a directional axis between the free end and the associate first and second adjacent  
3 portions, and wherein the directional axis extends across the longitudinal axis while the at  
4 least one microstructure is in the undeployed position.

1 19. An apparatus as in claim 16, wherein the microstructures extend  
2 radially a distance of between 25  $\mu\text{m}$  and 5000  $\mu\text{m}$  from the radially expandable body.

1 20. An apparatus as in claim 16, wherein the free end has a pointed shape.

1 21. An apparatus as in claim 20, wherein the pointed shape includes a  
2 single point, a multiple point, an arrow shaped point including a pointed tip and at least one  
3 undercut, or a combination of these.

1 22. An apparatus as in claim 16, wherein the relative movement of the  
2 associated first and second portions of the expandable body comprises circumferential  
3 movement of the first portion relative to the second portion when the expandable body  
4 expands radially.

1 23. An apparatus as in claim 22, wherein the associated first and second  
2 portions are in circumferential alignment and the circumferential movement of the first  
3 portion relative to the second portion draws the free end toward the circumferential  
4 alignment.

1 24. An apparatus as in claim 22, wherein the circumferential movement  
2 pulls the affixed ends of the first and second supports apart which moves the free end.

1 25. An apparatus as in claim 24, the radially expandable body further  
2 comprising an interior lumen along the longitudinal axis configured for receiving an  
3 expandable member which expands the expandable body, wherein the movement of the free  
4 end creates friction against the expandable member as the expandable member expands the  
5 expandable body, the friction projecting the free end radially outwardly.

1                   26.     An apparatus as in claim 24, the radially expandable body further  
2 comprising an interior lumen along the longitudinal axis configured for receiving an  
3 expandable member which expands the expandable body, wherein expansion of the  
4 expandable body by the expandable member pulls the affixed ends of the first and second  
5 supports apart which torsionally deforms the first and second supports projecting the free end  
6 radially outwardly.

1                   27.     An apparatus as in claim 24, wherein the radially expandable body is  
2 self-expanding composed and the self-expansion of the expandable body pulls the affixed  
3 ends of the first and second supports apart which torsionally deforms the first and second  
4 supports projecting the free end radially outwardly.

1                   28.     An apparatus as in claim 16, wherein the first and second supports  
2 comprise elongate shafts extending between the free end and the associated first and second  
3 adjacent portions of the radially expandable body.

1                   29.     An apparatus as in claim 28, wherein the relative movement of the  
2 associated first and second portions of the expandable body comprises moving the associated  
3 first and second portions apart so that the supports pull the free end in opposite directions  
4 causing the free end to project radially outwardly.

1                   30.     An apparatus as in claim 28, wherein the elongate shafts are adjacent  
2 to each other and aligned with a circumference of the expandable body in the undeployed  
3 position.

1                   31.     An apparatus as in claim 16, wherein each microstructure further  
2 comprises a third support affixed to an associated third portion of the radially expandable  
3 body, the associated first and third portions being connected so as to move in unison.

1                   32.     An apparatus as in claim 31, wherein the first, second and third  
2 supports comprise elongate shafts attached to the free end and to the associated first, second  
3 and third adjacent portions of the radially expandable body, respectively, and wherein the  
4 second support is disposed longitudinally between the first and third supports.

1                   33.     An apparatus as in claim 32, wherein the relative movement of the  
2 associated first and second portions of the expandable body comprises moving the associated

3 first and second portions apart while the associated third portion moves in unison with the  
4 associated first portion, so that the supports pull the free end in opposite directions forming a  
5 tripod structure which projects the free end radially outwardly.

1           34. An apparatus as in claim 1, wherein the at least one microstructure  
2 comprises a plurality of microstructures disposed near the proximal end and/or the distal end  
3 and not therebetween.

1           35. An apparatus as in claim 1, wherein the at least one microstructure  
2 comprises a plurality of microstructures disposed between the proximal and distal ends and  
3 not substantially near the ends.

1           36. A system for treating a patient comprising:  
2 an expandable body having a proximal end, a distal end, and at least one  
3 deployable microstructure, wherein expansion of the body deploys the at least one  
4 microstructure to project radially outward from the expandable body; and  
5 a material carried by the at least one microstructure, wherein the material is  
6 delivered to the patient by the at least one microstructure.

1           37. A system as in claim 36, wherein the material is coated on a surface of  
2 the at least one microstructure.

1           38. An apparatus as in claim 36, wherein the at least one microstructure  
2 includes a lumen and the material is held in the lumen.

1           39. An apparatus as in claim 38, wherein the expandable body further  
2 includes a delivery microsystem and the material is delivered to the lumen from the delivery  
3 microsystem.

1           40. An apparatus as in claim 39, wherein the delivery microsystem  
2 includes a therapeutic delivery control device which delivers the material to the lumen at  
3 predetermined intervals.

1           41. An apparatus as in claim 40, wherein delivery is triggered by an  
2 external signal in the form of a radiofrequency signal, an injectable chemical signal, an  
3 ultrasonic signal or a combination of these.

1                   42.     A system as in claim 36, wherein the material comprises at least a  
2 gene, at least a drug or a combination of these.

1                   43.     A system as in claim 42, wherein the material comprises a gene  
2 encoding for nitric oxide synthase or vascular endothelial growth factor.

1                   44.     A system as in claim 42, wherein the material comprises prednisone,  
2 low molecular weight heparin, low molecular weight hirudin, Rapamycin/Sirolimus,  
3 Paclitaxel, Tacrolimus, Everolimus, Tyrphostin AG 1295, CGS-21680 Hydrochloride, AM  
4 80, Estradiol, Anti-sense compounds, E2F Decoys, or a combination of these.

1                   45.     A system as in claim 42, wherein the material comprises DNA and an  
2 adhesive material to which DNA adheres.

1                   46.     A system as in claim 42, wherein the material comprises a  
2 biocompatible material which provides a protective coating to the drugs and/or genes.

1                   47.     A method of treating a patient comprising the steps of:  
2                   providing an expandable body having a proximal end, a distal end, a  
3 longitudinal axis therebetween and at least one microstructure having an end attached to the  
4 body and a free end;  
5                   positioning the expandable body within a vessel of the patient, wherein the at  
6 least one microstructure is in an undeployed position; and  
7                   expanding the body within the vessel so that forces are created which deploy  
8 the at least one microstructure, the free ends of the deployed microstructures projecting  
9 radially outward from the expandable body.

1                   48.     A method as in claim 47, further comprising expanding the body so  
2 that the deployed at least one microstructure penetrates the vessel wall.

1                   49.     A method as in claim 48, wherein the body comprises a stent and  
2 penetration of the vessel wall anchors the stent within the vessel.

1                   50.     A method as in claim 48, wherein the wall of the vessel comprises an  
2 intimal layer, a medial layer and an adventitial layer, and wherein expanding the body  
3 penetrates the free end through at least the intimal layer.

1           51.     A method as in claim 50, wherein expanding the body penetrates the  
2 free end through at least the medial layer.

1           52.     A method as in claim 47, wherein expanding the body comprises  
2 inflating an inflatable member within the body so as to increase its cross-sectional diameter.

1           53.     A method as in claim 47, wherein the body is self-expanding and  
2 expanding the body comprises releasing the body to allow self-expansion.

1           54.     A method as in claim 47, wherein the at least one microstructure  
2 carries a material and further comprising delivering the material to the patient.

1           55.     A method as in claim 54, further comprising expanding the body so  
2 that the deployed at least one microstructure penetrates the vessel wall, wherein the material  
3 is coated on a surface of the at least one microstructure and delivering the material comprises  
4 transferring the material from the surface of the at least one microstructure to the penetrated  
5 vessel wall.

1           56.     A method as in claim 54, further comprising expanding the body so  
2 that the deployed at least one microstructure penetrates the vessel wall, wherein the material  
3 is held in a lumen within the at least one microstructure, and delivering the material  
4 comprises injecting the material into the penetrated vessel wall.

1           57.     A method as in claim 54, wherein the material comprises at least a  
2 gene, at least a drug or a combination of these.

1           58.     A method for treating a patient comprising the steps of:  
2           providing an expandable body having a proximal end, a distal end, and at least  
3 one deployable microstructure carrying a material;  
4           positioning the expandable body in an undeployed position within a vessel of  
5 the patient;  
6           expanding the body to a deployed position within the vessel, wherein  
7 expansion of the structure deploys the at least one microstructure to project radially outward  
8 from the expandable body;  
9           penetrating a wall of the vessel with the at least one microstructure; and

10 delivering the material from the at least one microstructure to the wall of the  
11 vessel.

1 59. A method as in claim 58, wherein the material is coated on a surface of  
2 the at least one microstructure and delivering the material comprises transferring the material  
3 from the surface of the at least one microstructure to the penetrated vessel wall.

1 60. A method as in claim 58, wherein the material is held in a lumen  
2 within the at least one microstructure, and delivering the material comprises injecting the  
3 material into the penetrated vessel wall.

1 61. A method as in claim 58, wherein the material comprises at least a  
2 gene, at least a drug or a combination of these.

1 62. A method as in claim 58, wherein expanding the body comprises  
2 inflating an inflatable member within the body so as to increase its cross-sectional diameter.

1 63. A method as in claim 58, wherein structure is self-expanding and  
2 expanding the structure comprises releasing the structure to allow self-expansion.

1 64. An apparatus for treating a patient comprising:  
2 an expandable body having an inner ring and an outer ring surrounding a  
3 longitudinal axis; and  
4 at least one microstructure, each microstructure having first and second  
5 supports and a free end, the first support affixed to the inner ring and a second support affixed  
6 to the outer ring,  
7 expansion of the expandable body within the patient effecting relative  
8 movement between the inner ring and the outer ring,  
9 the relative movement deploying the at least one microstructure from an  
10 undeployed position to a deployed position with the free end projecting radially outwardly  
11 from the expandable body.

1 65. An apparatus as in claim 64, wherein the first and second supports are  
2 rotateably connected near the free end.

1 66. An apparatus as in claim 64, wherein the microstructures extend  
2 radially a distance between 25  $\mu\text{m}$  and 5000  $\mu\text{m}$  from the radially expandable body.



1                   67.    An apparatus as in claim 64, wherein the free end has a pointed shape.

1                   68.    An apparatus as in claim 67, wherein the pointed shape includes a  
2 single point, a multiple point, an arrow shaped point including a pointed tip and at least one  
3 undercut, or a combination of these.

1                   69.    An apparatus as in claim 64, further comprising a material carried by  
2 the at least one microstructure, wherein the material is delivered to the patient by the at least  
3 one microstructure.

1                   70.    An apparatus as in claim 69, wherein the material comprises at least a  
2 gene, at least a drug or a combination of these.

1                   71.    An apparatus for treating a patient comprising:  
2                   an expandable body having a proximal end, a distal end, a longitudinal axis  
3 therebetween, and at least one microstructure having an attached end attached to the body and  
4 a free end in an undeployed position,  
5                   the at least one microstructure deployable by rotation of the free end radially  
6 outwardly from the expandable body.

1                   72.    An apparatus as in claim 71, wherein the expandable body has an outer  
2 surface and wherein the attached and free ends are aligned with the outer surface in the  
3 undeployed position.

1                   73.    An apparatus as in claim 71, wherein the expandable body has an inner  
2 lumen and the at least one microstructure has a protruding region between the attached end  
3 and the free end which protrudes into the inner lumen, the at least one microstructure  
4 deployable by applying a force to the protruding region from within the inner lumen.

1                   74.    An apparatus as in claim 73, wherein the at least one microstructure is  
2 deployable by applying force radially outwardly against the protruding region.

1                   75.    An apparatus as in claim 74, wherein the at least one microstructure is  
2 deployable by applying force radially outwardly against the protruding region by expansion  
3 of an expandable member within the inner lumen.

1                   76.     An apparatus as in claim 73, wherein the protruding region forms an  
2 angle between the attached end and the free end.

1                   77.     An apparatus as in claim 71, wherein the attached end is attached to the  
2 body by a rotateable joint.

1                   78.     An apparatus as in claim 71, further comprising a material carried by  
2 the at least one microstructure, wherein the material is delivered to the patient by the at least  
3 one microstructure.

1                   79.     A method of treating a patient comprising the steps of:  
2                   providing an expandable body having a proximal end, a distal end, a  
3 longitudinal axis therebetween, an inner lumen and at least one microstructure having an end  
4 attached to the body, a free end and a protruding region therebetween which protrudes into  
5 the inner lumen;  
6                   positioning the expandable body within a vessel of the patient, wherein the at  
7 least one microstructure is in the undeployed position; and  
8                   applying a force against the protruding region from within the inner lumen  
9 which deploys the at least one microstructure to a deployed position wherein the free ends of  
10 the deployed microstructures project radially outwardly from the longitudinal axis.

1                   80.     A method as in claim 79, wherein applying a force against the  
2 protruding region comprises expanding an expandable member against the protruding region.

1                   81.     A method as in claim 80, wherein the expandable member comprises  
2 an inflatable member.

1                   82.     A method as in claim 79, wherein applying a force against the  
2 protruding region rotates the free end around the attached end.

1                   83.     A method as in claim 79, further comprising expanding the body so  
2 that the deployed at least one microstructure penetrates the vessel wall.

1                   84.     A method as in claim 83, wherein expanding the body comprises  
2 inflating an inflatable member within the body so as to increase its cross-sectional diameter.

1                   85.     A method as in claim 79, wherein the at least one microstructure  
2 carries a material and further comprising delivering the material to the patient.

1                   86.     A method as in claim 85, wherein the material comprises at least a  
2 gene, at least a drug or a combination of these.